LETTERS TO THE EDITOR.

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Magnetic Storm and Aurora, December 16-17.

THE following details of a noteworthy magnetic storm and aurora, which occurred on December 16–17, are communicated by permission of the Director of the Meteorological Office. C. CHREE.

Kew Observatory, Richmond.

ON the magnetic traces at Kew Observatory, Richmond, Surrey, there were indications of disturbance shortly after 8h. on December 16, but no striking movements until after 14h. (2 p.m.). Activity was greatest between 16h. and midnight of December 16, but some considerable movements appeared after midnight, and the disturbance did not die down until after 4h. on December 17. The range of declination (D) was about 34′, the ranges of horizontal force (H) and vertical force (V) being respectively about 400 γ and 250 γ. The needle reached its extreme westerly position about 14h. 40m., and its extreme easterly position just after 21h. Its largest continuous movement was a swing of 23′ to the west, occupying about thirty-five minutes, and ending just after 22h. The highest and lowest values of H occurred about 17h. and 21h. 15m. respectively; between these hours there was a general tendency to fall. A very rapid movement in H ended just before 21h. 15m., the element falling 215 γ in less than ten minutes. Between the end of this movement and 2h. 25m. on December 17, H rose almost 350 γ.

From 14h. 30m. until after 21h. on December 16 the D trace showed, superposed on a gradual drift to the east, a series of oscillations with a mean period of about twenty-two minutes. The H trace also showed a series of oscillations between 15h. and 18h., and the oscillations in the two elements were roughly in phase, increase in H going with westerly movement of the needle. The changes in V were of a normal kind, the value of the element being raised between 15h. and 22h. on December 16, and depressed in the early hours of December 17. The V trace was almost free from short-period oscillations, and these were also less conspicuous in the D and H traces than is usual with so large a disturbance.

The following particulars are reported from Eskdalemuir Observatory, Dumfriesshire, where the magnetographs record the north (N), west (W), and vertical (V) components of magnetic force:—

Time of commencement 8h. 17m. G.M.T. on December 16.

		h.	m.	Range
Maximum of N	at	17	23	638 γ
Minimum ,,	,,	21	27	
Maximum of W	,,	17	16	587 γ
Minimum ,,	,,	21	14	
Maximum of V	between	17	20	>579 γ
	and	17	35	
Minimum ,,	at	21	18	

These ranges, it will be noticed, especially that in V, are much larger than those recorded at Kew Observatory.

After the occurrence of the minimum values about 21h. 20m., the Eskdalemuir curves showed a recovery to about their normal positions; but just before 2h. on December 17 another disturbance was recorded, causing an increase in W and fall in N and V, the changes of force being approximately in N − 150 γ, in W + 80 γ, in V − 260 γ.

Observations of aurora on December 16 have been reported from many stations in Scotland and Ireland. At Eskdalemuir aurora was first noticed at 20½h., when it appeared as a glow to W.N.W. At 21h. an arc extended from about N.W. to about N.E., with green streamers extending towards the zenith. At 21h. 10m. the arc had disappeared, but the whole northern half of the sky up to the zenith was glowing brightly. At 21¼h. the glow was less extensive. It was noticed at this time that the streamers radiated to a point about 10° from the zenith towards the south (*i.e.* the radiant point had an elevation of about 80°, an azimuth of about 180°). The streamers were not thin and sharply defined, as is usually the case, but vaguely defined patches of light which glowed brightly. At 21½h. the principal glow was to the W. and W.S.W., but it was also plain to the N.W., N., and N.E. The natural inference was that the centre of the arc of the horizon from which the disturbance proceeded had changed azimuth from N (nearly) to W (nearly) between 21¼h. and 21½h., but the radiant point of the streamers did not change appreciably in position. A slight glow was still visible in the N.E. at 23h.

At Aberdeen Observatory, Mr. Clarke, the observer, reported a fine auroral display on December 16. From 16h. 45m. to 21h. it was of a comparatively stable character. Until 18h. there was a single curtain-arc, with crimson, yellow, and green colouring. Between 18h. and 21h. there were several similar arcs, coloured from yellowish-green to bluish-white. After 21h. the type altered, streamers appearing all over the sky, accompanied by a corona. This second auroral phase would seem to have synchronised with the very rapid fall of magnetic horizontal force at Richmond.

At Rothesay, according to the observer, Mr. J. Davidson, the aurora was very fine indeed. Along with extra long streamers were waves of red and white light, the whole centring overhead and forming an immense "dome" (corona), where both streamers and waves of light centred. The red waves came mostly from N.W. and N.E.

At Fort Augustus the "dome" was in the zenith at 21h. 15m. The most southerly station from which observations have been received at present is Seskin, near Waterford, where the aurora was "moderately bright" at 21h., and "faint" at 22h. The observer, Mr. Ernest Grubb, writes:—"The aurora on Sunday was much brighter at Mount Mellick, fifty-seven miles north of here, and very much brighter at Belfast, 174 miles north of here."

At Southport "a very fine display of streamers" was seen early on December 17, between 2½h. and 2¾h., and therefore corresponded with the second magnetic disturbance at Eskdalemuir.

SOURCES OF POTASH.

AS is well known, the world's supply of potash during the last three years has been greatly curtailed owing to the present isolation of Germany, and compounds of potassium have, consequently, greatly increased in price. This, of course, has acted adversely on the interests of agriculture, of medicine, and of numberless processes in the arts which are more or less dependent upon the use of potash compounds. Up to within comparatively recent times such potash as the world needed was obtained from sea-water, either directly, or indirectly through the medium of seaplants (*kelp* or *varec*); by the incineration of land-plants (wood-ashes); from *vinasse,* or the residue left on distilling fermented beetroot molasses; from *suint,* or the "yolk" of sheep's wool, etc. These still continue to be sources of potash, but they are of comparatively subordinate importance when compared with the relatively enormous output of the Stassfurt deposits. All these sources, including those of the Stassfurt beds, are ultimately dependent on the primitive rocks of the earth—that is, to the decomposition of such minerals as potash felspar, potash mica, and the vast number of zeolites and other silicates which make up much of the rock-forming material.

Felspars are, in fact, the most abundant minerals in the earth's crust, constituting, according to Dr. Hatch, about 48 per cent. of the whole, the potash felspars forming the predominant proportion. Orthoclase, when pure, should contain 16·9 per cent. of potash (K_2O), but such a theoretical figure is never reached, owing to a greater or less admixture of soda. About 12 per cent. of potash is the usual amount, which is rather more than the average percentage in the Stassfurt deposits. Many suggestions have been made from time to time to extract the potash from the two chief varieties of potash-felspar, viz. orthoclase and microcline, and from the intrusive igneous rock known as pegmatite, which is a mixture of quartz and felspar; and a large number of patented processes for this purpose are on record. It is said that upwards of one hundred patents on this subject have been taken out in the United States alone. One of the most promising of these was that of E. Bassett, who, in 1913, patented in the United States and Canada a process based on the discovery that powdered potash-felspar, when fritted with common salt, was decomposed, with the formation of potassium chloride, which could be leached out from the sintered material, and obtained sufficiently pure for technical purposes by fractional crystallisation.

This process was independently discovered, and has been carefully studied, by Mr. E. A. Ashcroft, who has brought it to the notice of the Institution of Mining and Metallurgy in a paper which has just been published (Bulletin No. 159, December 13, 1917). The reaction is a reversible one, and for its success in affording the maximum yield of potash certain conditions of fineness, temperature, duration of heating, and absence of air and moisture must be observed, which, however, would seem to be easily reached in practice. Large deposits of suitable material are to be met with in Great Britain, notably in Cornwall and in various parts of Scotland and Wales. Other localities occur in Ireland. Some of these are already worked for pottery purposes, but others, as in Sutherlandshire, on the extreme north-west coast of Scotland, are untouched, and would be eminently suitable sources of supply, and capable of yielding some 20,000,000 tons of material without going below visible outcrops.

Considerations of space prevent any fuller analysis of Mr. Ashcroft's proposals, but we are inclined to concur in his general conclusion that from a purely commercial point of view the attempt to work these Scottish deposits seems fully justified as likely to prove remunerative, and we further agree with his contention that, given the raw material of the potash trade (the chloride), manures and all other potash products can be produced at least as favourably in this country as in Germany, and that an important section of German trade may thus be wrested from her, whilst our own urgent needs for munitions of war, for the soil, and for the chemical industries may be supplied.

The Stassfurt deposits occupy an extensive basin in the North German Plain, in Prussian Saxony, close to the borders of Anhalt. The brine-springs which they furnish have been known and intermittently worked since the early part of the thirteenth century, but they ceased to be remunerative, as sources of common salt, in the first years of the nineteenth century, and their working was abandoned. In 1839 the Prussian Mining Office commenced a systematic examination of these deposits, and put down a number of borings in different parts of the area, with the result that the potash formations were found to occur in practically only one locality, near the River Bode, not far from Magdeburg. During the last third of the preceding century a new industry sprang up and the villages of Stassfurt and Leopoldshall, from being wholly insignificant places, became the centres of a numerous population.

The conditions under which the Stassfurt deposits have been formed were the subject of elaborate inquiry by van't Hoff and his coadjutors so long as the eminent Dutch chemist lived. Although his interpretation cannot be said to be wholly satisfactory, the investigation greatly elucidated the mode in which the beds are supposed to occur, and rendered it very probable that similar deposits will be found in other parts of the world. Indeed, their existence has already been proved. In 1909 large deposits of sylvine, or potassium chloride, were discovered in Upper Alsace, in an area of about 200 sq. km., near Mulhouse. Two strata were found, the upper 3 ft. thick, the lower more than 16 ft. thick at a depth of from 1600 ft. to 2100 ft. This field, unlike that of North Germany, seems to be continuous, without faults, and is of more recent geological origin.[1]

The issue of *La Nature* for November 24 contains an interesting account of what has been allowed to transpire concerning these Alsatian beds, from which the following particulars are taken. The deposits, although continuous, are far from being horizontal or uniform. On the contrary, they are folded and irregular. The lower layer of sylvine is surrounded and covered, throughout the whole of its extent, by the upper layer, arranged somewhat in the form of an ellipse, in plan not unlike, indeed, a painter's palette. At the edges the saline layers gradually thin out and disappear. From their great depth they are naturally at a high temperature, not less than 48° C. From statements made in 1912 it was calculated that the upper layer of sylvine contained about 98,000,000 cubic metres, distributed over 84,000,000 square metres, whereas the lower layer amounted to 603,000,000 cubic metres, spread over an area of 172,000,000 square metres, equivalent in round numbers to 1,500,000,000 tons of potassium salts, or 300,000,000 tons of pure potash. The first borings were made at Wittelsheim (originally in 1904, in searching for coal), and some fourteen others have been made over different parts of the area. The salt began to be won in 1910, and in 1912, from the Amelia mine, with 200 men, the daily output reached 300 tons. The mineral, brought to bank, was crushed and powdered and either treated directly for the manufacture of "muriate" or exported.

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[1] Cf. Prof. Lunge in Thorpe's "Dictionary of Applied Chemistry."

The potash layers are composed of bands, alternately red and grey, consisting principally of a mixture of sylvine and rock-salt. The red bands, coloured with ferric oxide, contain the principal amount of the potash salt, whereas the grey consist mainly of common salt. In addition there are found thin layers of argillaceous schist and anhydrite. The content of potassium chloride varies from 20 to 68 per cent., and rarely falls as low as 10 per cent. The raw products contain only insignificant quantities of magnesium salts and may, therefore, be used directly in agriculture after grinding. In this respect they are more advantageous than the Stassfurt salts, which need separation from the large quantities of associated magnesium salts. The Reichweiler factory is capable of treating daily about 260 tons of the raw mineral, producing from 40 to 50 tons of pure potassium chloride. The content of bromine is so small as not to be worth extraction.

The production of Alsatian potash is carefully regulated by the German Government, and by the law of May 25, 1910, the Amelia mine, the only one actually at work in Alsace, was allowed to produce no more than 1·46 per cent. of the total yield of the Empire, *i.e.* 9000 tons of pure potash, or 45,000 tons of raw salt, corresponding with an extraction of fifteen wagons per diem, far below what it was capable of affording. At the beginning of the war, in spite of some improvement in the situation, the fifteen Alsatian mines, capable of yielding in the aggregate about 800,000 tons per annum, were allowed to sell only 80,000 tons, and the total amount reserved to Alsace was permitted to be only about one-tenth of the German production. This action is, of course, due to the attempts of the German authorities to control and strengthen the monopoly they practically possess—a condition which would be altogether modified by the return of Alsace to France, and by the *rôle* which the State mines of Stassfurt might be made to play in the case of a war indemnity by Germany.

Of the other considerable natural deposits which are known to occur, the most important are those of Spain and Abyssinia. The Spanish beds occur at Suria, in Catalonia, and to-day belong to the Solvay Company. They have been found at depths of from 40 m. to 60 m., but certainly extend much deeper. They date probably from the end of the Eocene or the beginning of the Oligocene period and are widely distributed, the potash salts occurring irregularly mixed with rock-salt. The potash compounds consist of carnallite and sylvine in layers of an intense red colour, with alternate reddish layers of common salt. The richest zones appear to follow anticlinal folds running from south to north to Cardona, Suria, and Callus. The area explored is only some 230,000 square metres, but it is said to contain about two and a half million tons of carnallite and nearly a million and a quarter tons of sylvine in local thicknesses of 17 m. of carnallite and 3·75 m. of sylvine. At present these Spanish deposits are not utilised, owing to the influence of Germany on Spanish affairs. The Cortes was offered a Bill in order to promote the working of the mines, but it was opposed by a faction in the interests of Germany, and no result followed. A Royal decree in June, 1915, modified the conditions, but these were still so restrictive that the Solvay Company was prevented from exploiting the mines. On the other hand, certain Spanish corporations, working in concert with the German syndicate at Stassfurt, have obtained concessions in the vicinity of Cardona, and State reservations have been created in the provinces of Barcelona and Lerida; but no further action has been taken, ostensibly on the ground that the Spanish Geological Institute has not yet completed its explorations.

The Abyssinian deposits belong to Italy. They occur in Erythrea, at 90 km. from the coast to the south-east of Massaoua, and at 10 km. to the north of Atel Bad in long. 40°, close to the Italian frontier. Their exploitation has hitherto been very difficult, owing to the hostility of the Abyssinians. These conditions are now notably improved, partly by a more effective possession by the Italians, and partly by recent changes in the Government of Abyssinia, which is more favourably disposed towards the Allies. The deposits already furnish about 20,000 tons per annum. Not much is known concerning their physical characteristics or the conditions of their formation, but they are certainly much more recent than those of Alsace and Spain, which are Tertiary; they have probably been formed by the comparatively recent evaporation of an ancient arm of the sea running north and south, due to one of the great lines of rupture extending from Palestine and traversing the whole of the east of Africa along a region still of volcanic activity.

Conditions such as probably have produced the Stassfurt deposits are still at work and may be observed in several parts of the world operating over large areas, as, for example, in the Adji-Darja Bay, in the east of the Caspian Sea—a bay 2000 to 3000 square miles in extent, and almost entirely shut off from the Caspian by a bar. There is here a continuous separation of salt, estimated by Schleiden to be about 400,000 tons per diem, with an outflow of dense mother-liquor back to the Caspian, except where it sinks in the deeper parts of the bay, when the mother-liquor salts are gradually deposited. None of these areas has been investigated with such care as that of the North German Plain, but the general conditions which have led to their production are seen to be similar, although local circumstances, especially the extent to which they were subjected to an intermittent influx of sea-water, have modified the nature, relative amounts, and distribution of their various saline constituents. T. E. THORPE.

NATIONAL POWER SUPPLY.[1]

THE interim report issued by the Coal Conservation Sub-committee presided over by Lord Haldane will be read with great interest, as it crystallises the considered opinions of eminent engineers. The committee has little difficulty in proving that the present system of electrical power distribution in this country is most uneconomical. If it had all to be done *de novo* the Committee would divide the country into some sixteen districts. In each district there would be several large inter-connected super-stations for generating electric power, and these would be controlled by a single authority. The sites of these stations would not be chosen, as they too often are at present, mainly to secure that the "rates" payable on the electric works may come to the local authority working the undertaking, but they would be chosen on the lines laid down by Kelvin in 1878. They would therefore be either near the pit's mouth, where coal dross could be used for working engines of the most economical type, or in places where plenty of condensing water is available, where coal transport is cheap, and where they would be near the centre of gravity of the probable demand. If this were done it is calculated that as many as 55,000,000 tons of coal would be saved per annum, a saving that would far more than counterbalance the interest payable on the new capital necessary.

We agree with the Committee that it is in the national interest that the change should be made as soon as possible, and we think that the probable saving that would be effected has been somewhat under-estimated. Both Mr. C. H. Merz and Mr. C. P. Sparks, who are members of the Committee, have shown by the stations they have designed the great commercial possibilities of "supply in bulk," and what a boon it is in industrial areas. They are not inviting the country to take any speculative risks—the pioneer work has all been done. Dr. Ferranti, Lord Crawford, and Mr. Ince thoroughly appreciated the main facts of the problems in 1888, when the Deptford power station was first designed.

The Committee is right in saying that the difficulties which stand in the way are "political" rather than "engineering." There are too many vested interests at stake—those of engineers as well as capitalists—to make the course of any national power supply scheme a smooth one. The suggestion of a Board of Electricity Commissioners is a good one, but the powers of the Board will have to be very carefully defined. Everyone will agree that the Board should be empowered to stop the extension or multiplication of uneconomical stations for public supply, and that it should aim at ultimately securing the adoption of a bulk supply scheme somewhat similar to that outlined in the report under notice.

It will be interesting to see how far the conclusions of the report will be endorsed by the Board of Trade Electric Supply Committee, which is at present sitting, and on which municipal engineers are represented. In any event the Sub-committee is to be congratulated on having made excellent and timely suggestions.

ECONOMISING SUGAR.

OUR contemporary, *La Nature,* devotes an article in a recent number (December 1) to a consideration of the use of substitutes for sugar, in view of the present shortage of that commodity. Sugar is a foodstuff; but as a nutrient it can be replaced by other carbohydrates, such as those contained in farinaceous foods and vegetables. The essential thing as regards sugar is to find a substitute with sweetening properties. Glucose, obtained by hydrolysing starch with sulphuric acid, is the only sugar other than the ordinary supplies producible in large quantities; but it has a low sweetening power, is not economical, and has reached an almost prohibitive price in France. There remain the sweet chemical products, of which the two chief are dulcin and saccharin. Dulcin, para-ethoxyphenyl urea, is obtained from phenetidine and urea, and has about two hundred times the sweetness of cane-sugar. It has not, however, been much used as a sweetener, since saccharin is cheaper and much more effective. This compound, it may be recalled, has for its parent substance toluene—the coar-tar product which serves also to provide the explosive trinitrotoluene. In making saccharin, toluene is converted first into its sulphochloride and then into the sulphonamide, which is oxidised with potassium permanganate to produce orthosulphamidobenzoic acid. Saccharin is the anhydride, or imido-derivative, of this acid; it is claimed to be about five hundred and fifty times as sweet as cane-sugar. It is not very soluble in water, and is generally employed in the form of its sodium or ammonium salt (sucramine), both of which are readily soluble.

Before the outbreak of war saccharin was chiefly made in Germany, but had been produced in this country to a small extent, and the manufacture has again been taken up here quite recently. In France four factories have lately been equipped to produce it. As regards the raw materials, ordinarily these would be accessible enough and cheap enough, but at present there is, of course, a great demand for toluene, and potassium salts are scarce. Nevertheless, a certain quantity of toluene can presumably be spared for urgent wants, and there is no absolute necessity to use *potassium* permanganate as oxidising agent. In any case the French factories are proceeding with the manufacture, and, as our contemporary observes, *"la pro-*

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[1] Reconstruction Committee: Coal Conservation Sub-committee. Interim Report on Electric Power Supply in Great Britain. Cd. 8880. (London: Imperial House, Kingsway, W.C.2.) Price 3*d*. net.